[0064] The feature that clusters may be allocated in any order may be utilized in another way. In an embodiment, the scheduler is configured to allocate a cluster to user equipment for uplink transmission, the cluster being smaller than any subsequent cluster to be allocated. As the next cluster to be allocated in larger than the already allocated cluster, the scheduler may remove from the tree structure all the clusters which are smaller than the allocated cluster. The remaining clusters are then denoted with new index values which are used when signaling the second cluster to the user equipment. Thus, the number of indexes may be reduced and the signaling load reduced. The process may be repeated again if more than two clusters are allocated.

[0065] FIG. **2**D illustrates this embodiment. In the example of FIG. **2**D, let us assume that clusters having indexes 152 and 177 are to be allocated to user equipment. As the cluster having the index 152 is smaller, it is allocated first. Then, all clusters which are smaller in size that the cluster having the index 152 may be removed from the tree. In this example all clusters having the size of one or two PRBs may be removed.

[0066] In the above embodiments, there are no restrictions to the allocation of the clusters. However, to obtain higher savings in the signaling load, some restrictions may be utilized. One goal could be to be able to signal the allocation of two clusters using 14 bits, which corresponds to the signaling load of the one cluster/20 MHz case in LTE Release 8 (including the frequency hopping flag; it is assumed that frequency hopping is not used with clustered resource block mapping).

[0067] If no optimizations are done in the resource allocation (including the above described methods), then the number of states needed at 20 MHz is 4940.

[0068] In an embodiment, the scheduler is configured to allocate a first cluster and a second cluster to user equipment, the first cluster having an even or odd index value and the second cluster having an odd index value. This would save ¼ of states, i.e., 3712 states would be needed. In the example of FIG. **2**A, let us assume that the first cluster is odd and the second cluster is even (using the original indexing). After selecting the index of the first cluster, the odd numbered clusters can be removed from the tree and the remaining clusters denoted with new index values.

[0069] In an embodiment, the scheduler is configured to allocate clusters to user equipment, wherein all clusters have either even or odd index value. This method will save half of the states, that is, 2475.

[0070] In an embodiment, the scheduler is configured to allocate clusters to user equipment, the cluster having even or odd index values, and the allocation is based on a predetermined property of the user equipment. The property may be user equipment identification (ID) or some other user equipment specific property. The property may also change with time. For example, the property may be a function of the user equipment ID and a subframe number. This method may save up to ¾ of the states, down to 1238, and allows signaling of all remaining states with just 14 bits.

[0071] In an embodiment, the scheduler is configured to allocate a cluster with an index m to user equipment; and allocate a second cluster with an index n-m, where n is the total number of clusters on the particular branch. This restricts the allocation of clusters having the size of one PRB. Only specific combinations of clusters are allowed. This still allows exploiting diversity for allocating single PRBs, but it is not possible to schedule allocations of two single PRB clusters in the "holes" that are left after scheduling other users.

[0072] In an embodiment, the scheduler is configured to allocate clusters having a length of a single physical resource block only from either the beginning or the end of the resource block space. FIG. **2**E illustrates this embodiment. The resource space may have predetermined areas **220**, **222** at the beginning and the end of the resource block space from which clusters of a single PRB size may be allocated.

[0073] In an embodiment, the scheduler is configured to align the resource allocation tree structure at least partially with the tree structure used in the allocation of a sounding reference signal (SRS). The sounding reference signal is a signal transmitted by the user equipment providing information regarding uplink channel quality. The network may utilize the channel information on the uplink resource allocation (i.e., scheduling of the clusters).

[0074] In LTE, the available sounding reference signal bandwidths are in the form of a tree structure, comprising several branches. FIGS. **3**A and **3**B illustrate two examples of the SRS tree structure. In FIG. **3**A, the tree comprises four branches **300**, **302**, **304** and **306**, where on the first branch **300**, the size of each cluster is four physical resource blocks, and the sizes of the other branches **302**, **304** and **306** are **24**, **48** and **96**, correspondingly. In FIG. **3**B, the tree comprises four branches **308**, **310**, **312** and **314**, where on the first branch **308**, the size of each cluster is four physical resource blocks, and the sizes of the other branches **310**, **312** and **314** are **16**, **48** and **96**, correspondingly.

[0075] In an embodiment, the scheduler is configured to align the resource allocation tree structure with the tree structure used in the allocation of the sounding reference signal starting from the resource allocation tree branch having clusters equal to the size of four physical resource blocks. As the sounding reference signal gives uplink channel information to the network, the channel information is the most accurate if the tree structure and SRS structure are aligned.

[0076] The network may configure the tree structure used in the allocation of the sounding reference signal for each cell separately.

[0077] FIG. **4**A is a flowchart illustrating an embodiment. In step **400**, a cluster is allocated to user equipment utilizing a tree structure with more than one branch in the resource allocation of physical resource blocks, each branch comprising one or more starting positions for resource allocation, each starting position defining a cluster of physical resource blocks, the number of starting positions being different on each branch, the size of the resource clusters of each branch being different, and denoting each resource cluster with a predefined index.

[0078] In step **402**, it is checked whether all required clusters have been allocated.

[0079] If not, step **400** is repeated.

[0080] If yes, the allocations are signaled to the user equipment in step **404**.

[0081] FIG. **4**B is a flowchart illustrating another embodiment. In step **400**, a cluster is allocated to user equipment utilizing a tree structure with more than one branch in the resource allocation of physical resource blocks, each branch comprising one or more starting positions for resource allocation, each starting position defining a physical resource block cluster, the number of starting positions being different on each branch, the size of the resource clusters of each branch being different, and denoting each resource cluster with a predefined index.